Failures, Mishaps and Root Cause Analysis

Leadership ViTS Meeting
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Katrina: What a surprise!

Excerpts from an October 2001 Scientific American article:

- "In 1965, Hurricane Betsy put parts of the city under 8 feet of water." *(That plus 78 deaths sounds like a mishap)*
- "In 1992, monstrous Hurricane Andrew missed the city by only 100 miles." *(This certainly qualified as a close call)*
- "In 1998, Hurricane Georges veered east at the last moment but still caused billions of dollars of damage." *(Close call…Mishap…where's the root cause analysis?)*
- "A major hurricane could swamp New Orleans under 22 feet of water, killing thousands." *(Several official risk assessments ignored, or at least taken lightly?)*

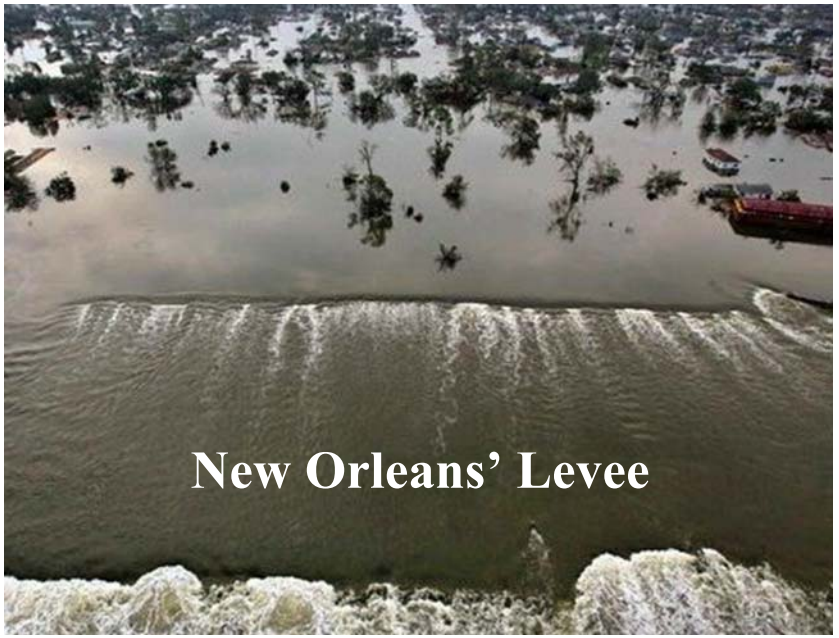
Investigating Causes of Failures & Mishaps

When looking at failures, such as those that contributed to the significant losses in New Orleans, it is necessary to look at more than just the immediately visible cause, which is often the proximate cause. (Such as the levee collapsed).

There are underlying organizational causes that are more difficult to see, however, they contribute significantly to catastrophe.

If not corrected, they will continue to create similar types of problems. These are root causes.

Root Cause Analysis identifies the root causes…what, how and why the catastrophe occurred (the 5 why's).



Root Cause Analysis performed after a mishap, failure or close call allows identification of systemic problems so we can avoid repeat.

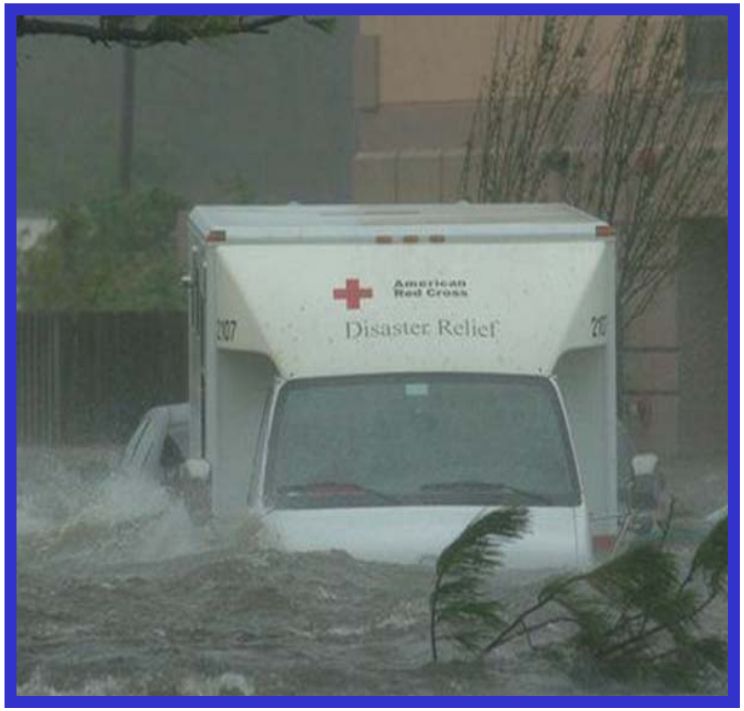
Underlying Causes of Failure and Mishap

- The failure investigation works to uncover the “proximate cause” so that engineers can go fix the hardware…it often stops there.
- The mishap or close call investigation needs to uncover both the proximate and the underlying or “root causes” to avoid repeats
- Unfortunately, confusion often exists about what root causes are and how they can be determined.

Definitions (NPR 8621.1A, App. A)

- Contributing Factor. An event or condition that may have contributed to the occurrence of an undesired outcome but, if eliminated or modified, would not by itself have prevented the occurrence.
- Proximate Cause. Event(s) that occurred, including any condition(s) that existed immediately before the undesired outcome, directly resulted in its occurrence and, if eliminated or modified, would have prevented the undesired outcome. Also known as the direct cause(s).
- Root Cause. One of multiple factors (events, conditions, or organizational factors) that contributed to or created the proximate cause and subsequent undesired outcome and, if eliminated or modified, would have prevented the undesired outcome. Typically, multiple root causes contribute to an undesired outcome.
- Root Cause Analysis. A structured evaluation method that identifies the root causes for an undesired outcome and the actions adequate to prevent recurrence. Root cause analysis should continue until organizational factors have been identified or until data are exhausted.
- Observation. A factor, event, or circumstance identified during the investigation that did not contribute to the mishap or close call, but, if left uncorrected, has the potential to cause a mishap or increase the severity of a mishap; or a factor, event, or circumstance that is positive and should be noted.

Possible Root Causes in New Orleans



- Failure to correct a known problem because of misplaced budget priorities
- Failure to periodically inspect/evaluate systems due to lack of adequate inspection/test protocols
- Failure to conduct adequate emergency planning, training, communication due to lack of realistic simulation
- Failure to understand the risk a significant hurricane posed due to lack of investment (or confidence) in risk analysis

How Are These Similar to the Root Causes of Mishaps Inside and Outside of NASA?

Almost Root Causes Non-NASA Examples

Causes of Errors in Design Process

(Companies in US & Japan)

- Schedule pressure
- Oversight
- Lack of testing
- Changing requirements
- Lack of structure
- Miscommunication
- Lack of prototyping

Causes of Errors in Maintenance

(FAA Dirty Dozen)

- Lack of communication
- Complacency
- Lack of knowledge
- Distraction
- Lack of teamwork
- Fatigue
- Lack of resources
- Pressure
- Lack of assertiveness
- Stress
- Lack of awareness
- Norms

Causes of Errors in Aviation

(FAA Research-119 Accidents)

- Crew resource mis-mgmt.
- Adverse mental states
- Physical/mental limitations
- Inadequate supervision
- Organizational process
- Failure to correct known problems

Each of these factors would benefit from at least one more "why"

Root Causes: NASA-like Examples
(better ones in bold)

Supervision
• "Failure to correct known problems" was a supervisory failure to correct similar known problems.
• **"Supervisory Violation" was committed by [Ops Mgr.] repeatedly waiving required presence of quality assurance and safety and bypassing Government Mandatory Inspection Points.**

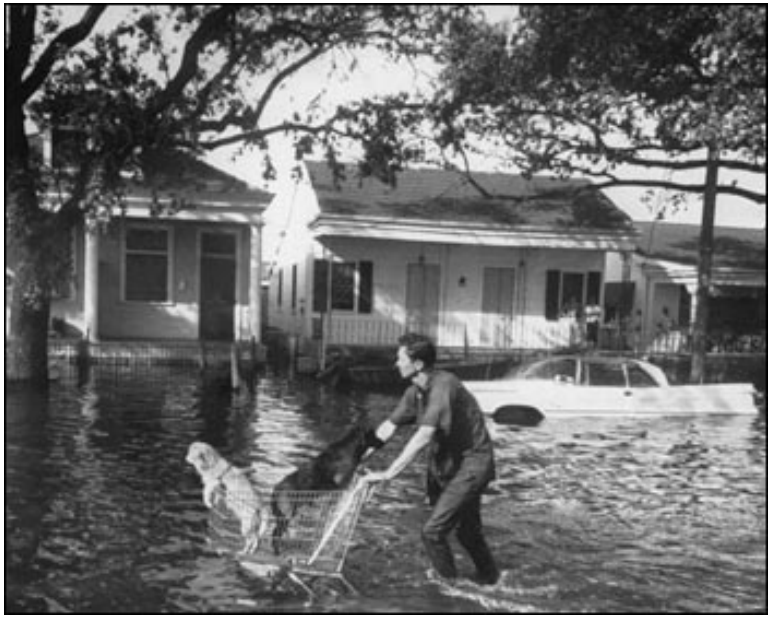
Reviews and Testing
• **Tests were cut because funding was cut, and there was no risk analysis done to characterize the impact**
• "Inadequate operation's team staffing".

Risk Assessment & Risk Mgmt
• **Did not consider the worst-case effect. Lacked systematic analyses of "what could go wrong."**
• Lack of adequate analysis methods led to an inaccurate risk assessment of the effects of configuration changes.

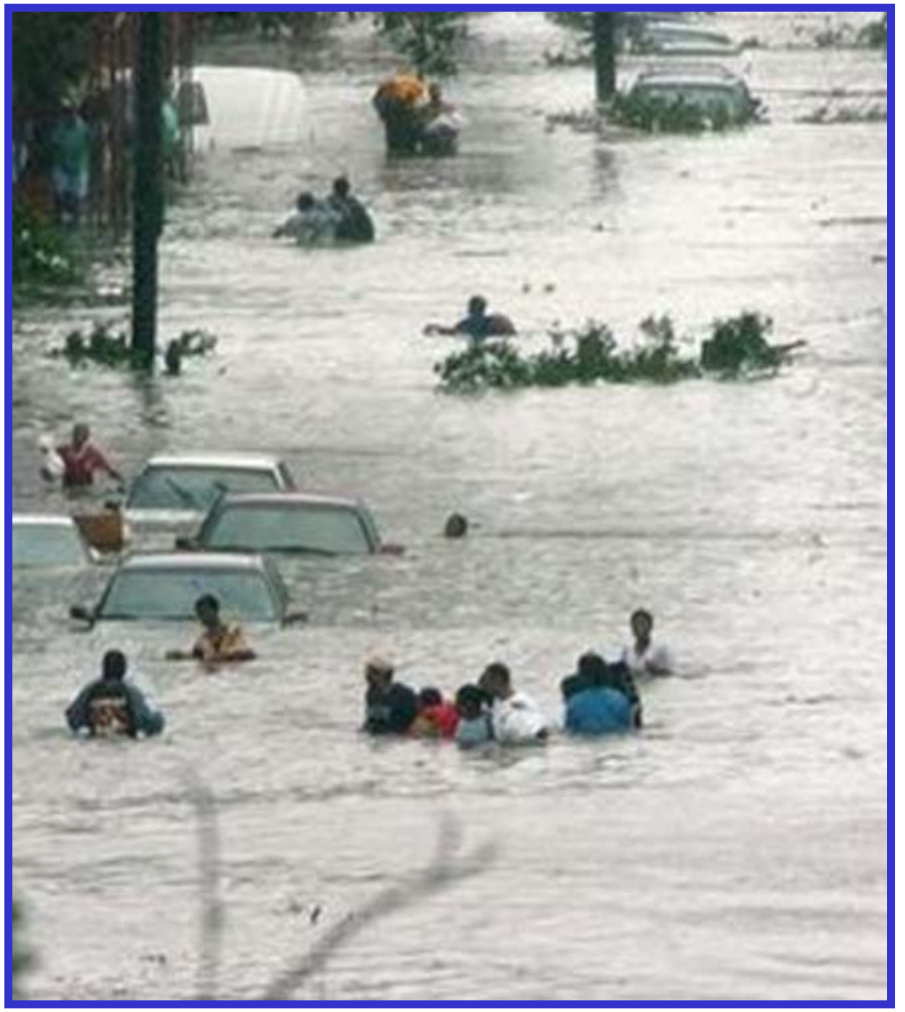
Design
• Logic design error existed - Design errors in the circuitry were not identified
• Drawing incorrect
• **System drawings were incorrect because they were not updated when system was moved from its original location to the Center.**

Conclusion

- Root Cause Analysis identifies what, how and why systemic problems occur.
- Without identifying and fixing the systemic organizational problems, the chance of repeat is significant.



Hurricane Betsy 1965



Hurricane Katrina 2005

For More Information

Refer to, and join if not a member,

PBMA Mishap Investigation Website

http://ai-pbma-kms.intranets.com/login.asp?link=

- Includes:
  - Documents (e.g., Methods, Techniques, Tools, Publications and Presentations).
  - Links (a Root Cause Analysis Library, to Root Cause Analysis Software, etc.).